Human-Computer Interaction for Mission Planning and Operations

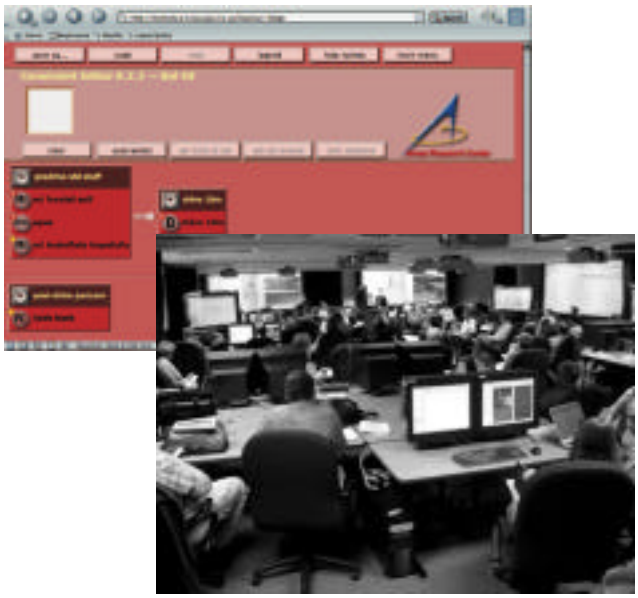
Today's mission tools operate at the edge of human cognitive ability. NASA's Space Exploration Vision demands even more advanced mission support tools. Research on Human-Computer Interaction for mission operations is focused on designing systems that allow users to accomplish increasingly complex tasks efficiently without increasing cognitive load and likelihood of costly errors.

Background

The Exploration Systems Initiative will place new demands on mission systems and their human operators both on the ground and in flight. Among these are likely to be stricter resource constraints, a higher degree of interaction with ground and flight automation, and increased limitations on communications and bandwidth. For example, astronauts performing CEV maintenance will need systems that allow them to interact with complex spacecraft systems and increasing levels of on-board automation without increasing cognitive load or error rate. Human-Computer Interaction research focuses on supporting the design of such systems in a way that reduces risk while considering limitations on the human operator's abilities and the context in which systems will be used.

Modern mission software tools often operate at the very limits of human attentional and cognitive capability. As these tools advance to accommodate the new demands of the exploration initiative, the demand on their human operators also threatens to increase. Some of the manifestations of an increase in demand on cognitive faculties beyond human capability are increased time on task, increased rate of errors, and additional stress placed on users. These factors can have significant impact on missions such as those described in the Exploration Initiative which place an even higher premium on these resources than present day missions.

It is the goal of Human-Computer Interaction for Mission Planning and Operations to consider these usability constraints early in the design process and guide tool development appropriately. If human operator constraints are not given due consideration at design time, these



limitations will appear later in the process where they are often costly or impossible to fix. Research methods in the area of Human-Computer Interaction are aimed at identifying human limitations and informing system design such that next generation systems can eliminate pitfalls and play to human strengths and weaknesses.

Research Overview

In order to accomplish the goal of decreased cognitive load in the face of ever increasing demands from technology, the Human-Computer Interaction (HCI) Group employs methods ranging from in-situ field observation to the iterative, user test-driven design. These methods are designed to collect reliable data on the usability of systems as early as the conceptual stage of mission design and continuing through the development and eventual deployment of the system.

Ames Supporting the NASA Mission

Human-Computer Interaction for Mission Operations

The data collected early through observation and user testing is used during design and development phases. The HCI Group has extensive observational and interview data on the use of mission systems which is used to inform the design of future multi-mission planning and operations software tools.

The HCI Group has contributed to the design of several mission-critical software tools deployed on the MER (MER) mission. *Constraint Editor* was designed to work with the MAPGEN mixed-initiative planning environment, and was used every day on both Spirit and Opportunity to plan rover activities. The MER mission introduced a new constraint-based planning paradigm in order accommodate disparate science requests and maximize scientific return. Previously this planning paradigm required users to manipulate hundreds of constraints manually while the tactical timeline only allowed about ten minutes for constraint creation. The HCI Group's answer to the problem was a graphical drag-and-drop solution which allowed users to create and manipulate constraints at a level of abstraction that was consistent with their mental model of the planning process. As a result, users were able to create constraints under time pressure and leverage the full capability of the MAPGEN mixed-initiative planning software.

In addition to mixed-initiative planning, current research is aimed at expanding the HCI Group's expertise into the areas of anomaly resolution and accident investigation. The first step in this process is an extensive in-context research phase that is aimed at baselining anomaly response procedures agency wide in a number of different mission operations contexts including MER, Gravity Probe-B and the SOFIA airborne observatory currently in the design and testing phase. This work will feed directly into the design and development of anomaly resolution and accident investigation tools to aid future Exploration missions.

Relevance to Exploration Systems

The Exploration Systems Initiative calls for a significant increase in capability of current mission systems, which will require more sophisticated software tools. Work in Human-Computer interaction is necessary to ensure the successful deployment of new mission systems and technology.

The HCI Group has already collected extensive baseline data from observation of past missions providing a valuable feed-forward foundation for designers of future missions and mission systems.

H&RT Program Elements:

This research capability supports the following H&RT program /elements:

ASTP: Software, Intelligent Systems & Modeling

TMP: Advanced Space Operations

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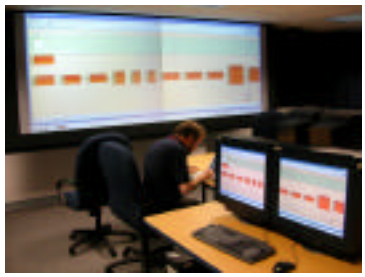

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